FIG. 1

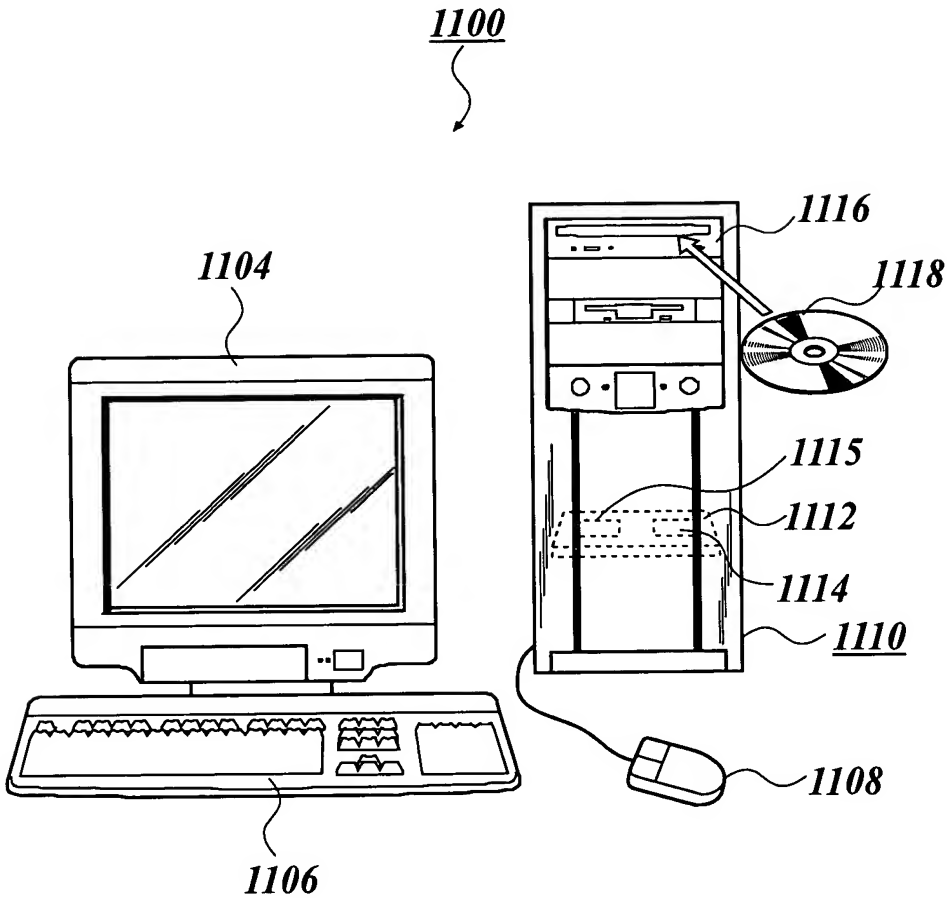


FIG.2

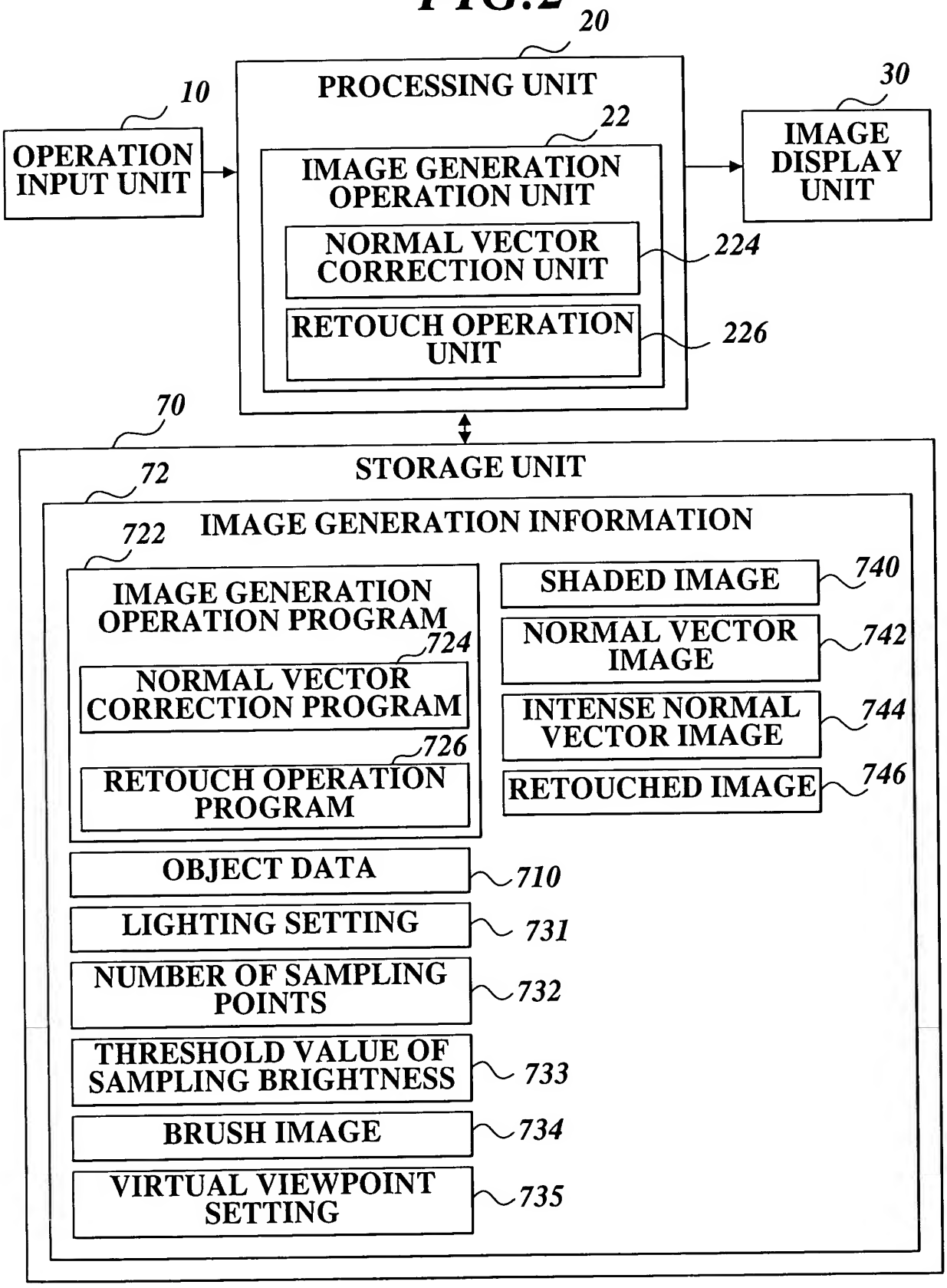

20
PROCESSING UNIT
10
OPERATION INPUT UNIT
22
IMAGE GENERATION OPERATION UNIT
NORMAL VECTOR CORRECTION UNIT
224
RETOUCH OPERATION UNIT
226
30
IMAGE DISPLAY UNIT
70
STORAGE UNIT
72
IMAGE GENERATION INFORMATION
722
IMAGE GENERATION OPERATION PROGRAM
724
NORMAL VECTOR CORRECTION PROGRAM
726
RETOUCH OPERATION PROGRAM
740
SHADED IMAGE
742
NORMAL VECTOR IMAGE
744
INTENSE NORMAL VECTOR IMAGE
746
RETOUCHED IMAGE
OBJECT DATA
710
LIGHTING SETTING
731
NUMBER OF SAMPLING POINTS
732
THRESHOLD VALUE OF SAMPLING BRIGHTNESS
733
BRUSH IMAGE
734
VIRTUAL VIEWPOINT SETTING
735

FIG.3

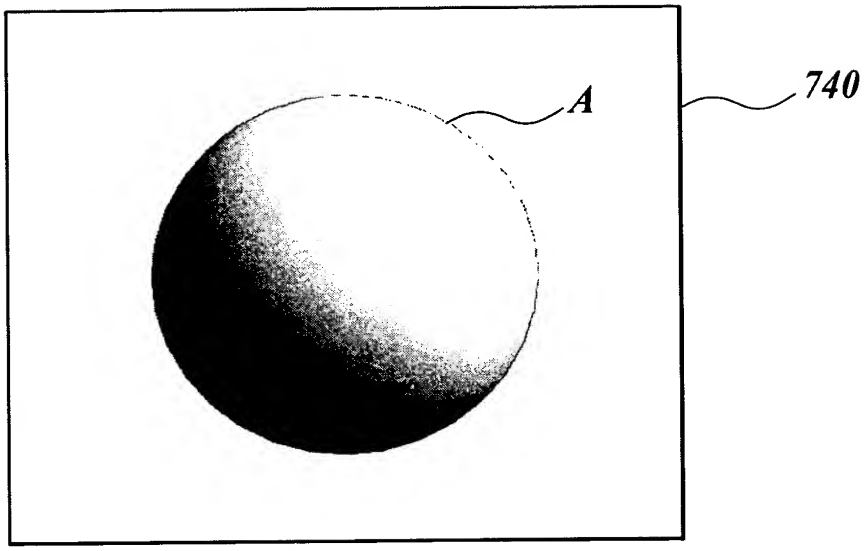


FIG.4

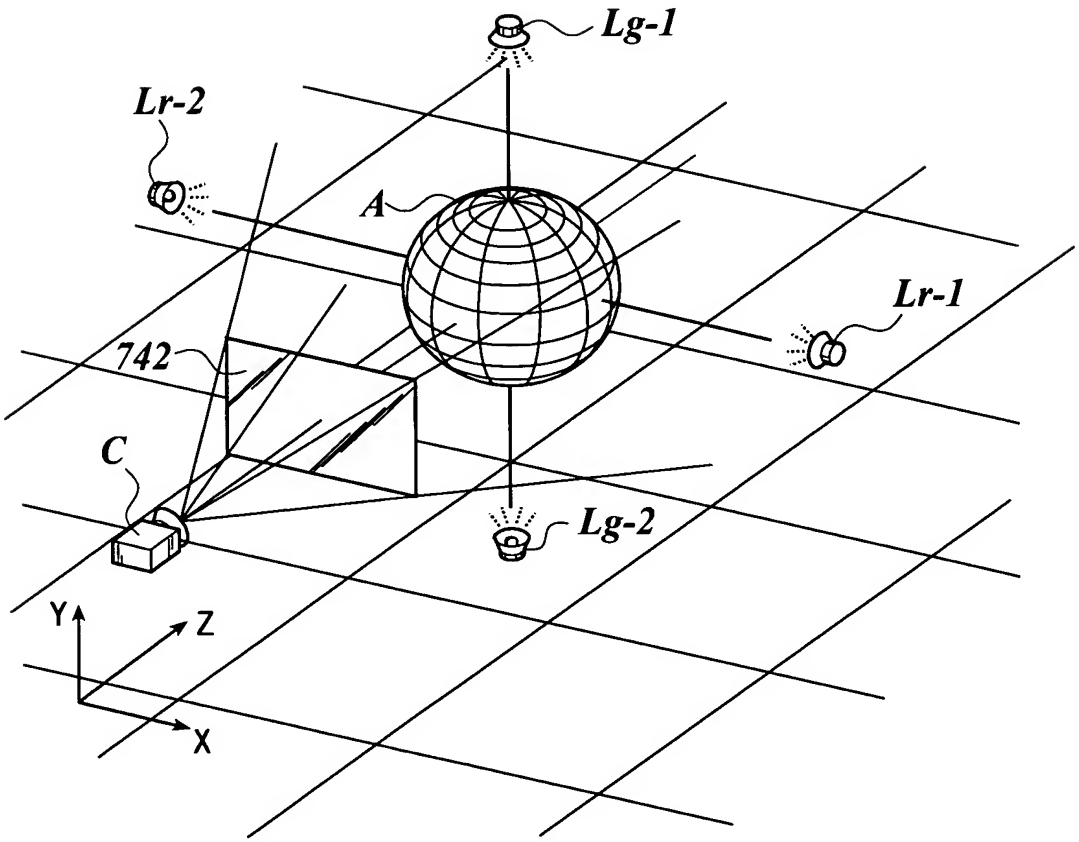


FIG. 5

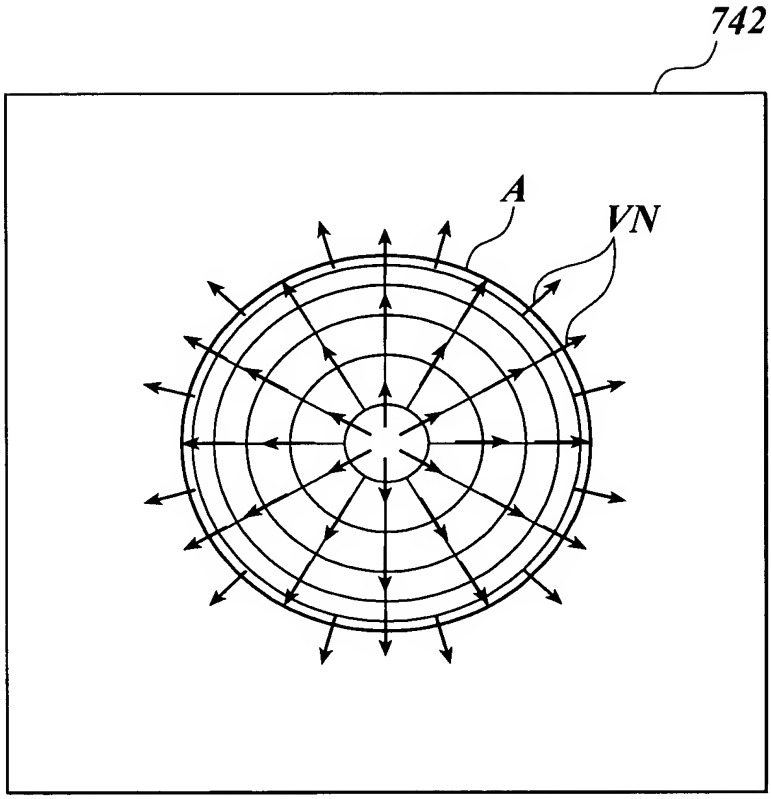


FIG.6

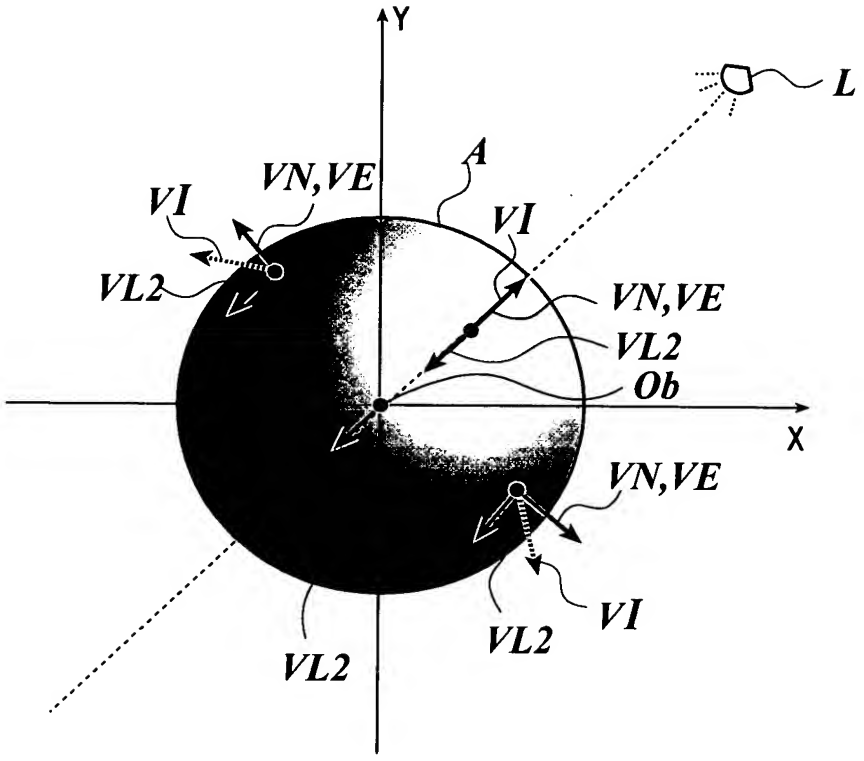


FIG. 7

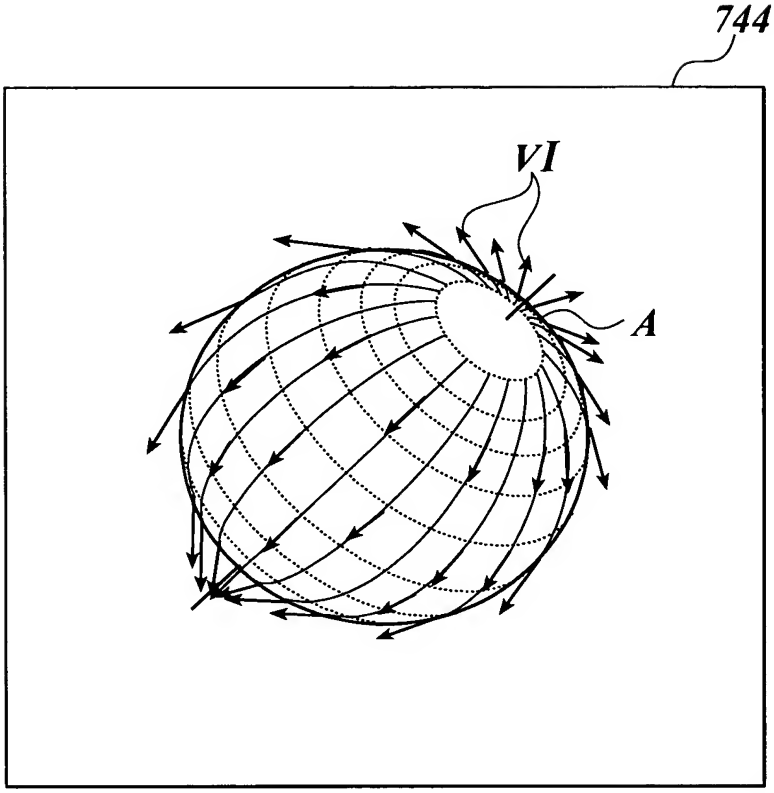


FIG.8A

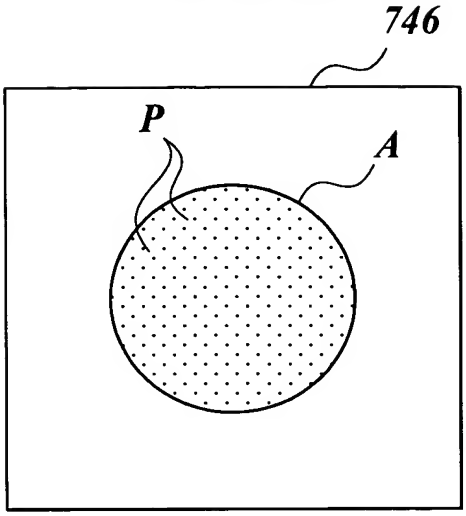


FIG.8B

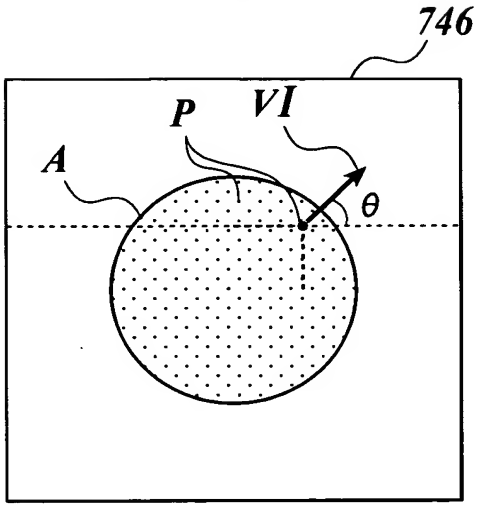


FIG.8C

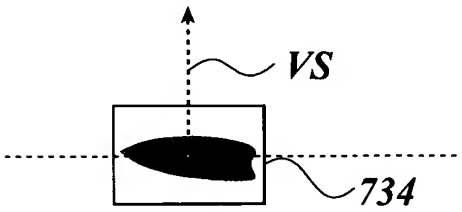


FIG.8D

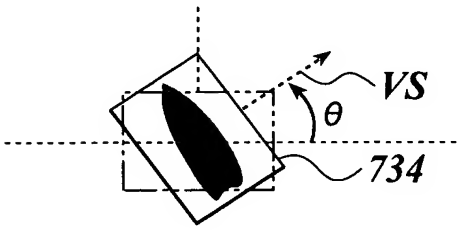


FIG.8E

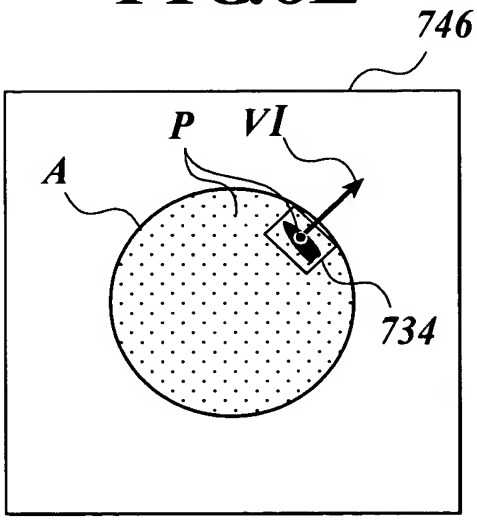


FIG.8F

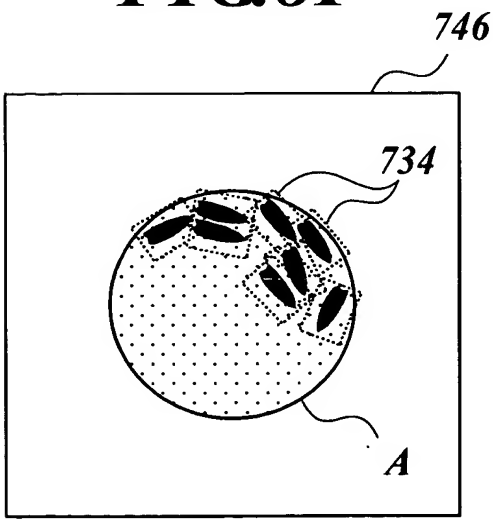


FIG.9

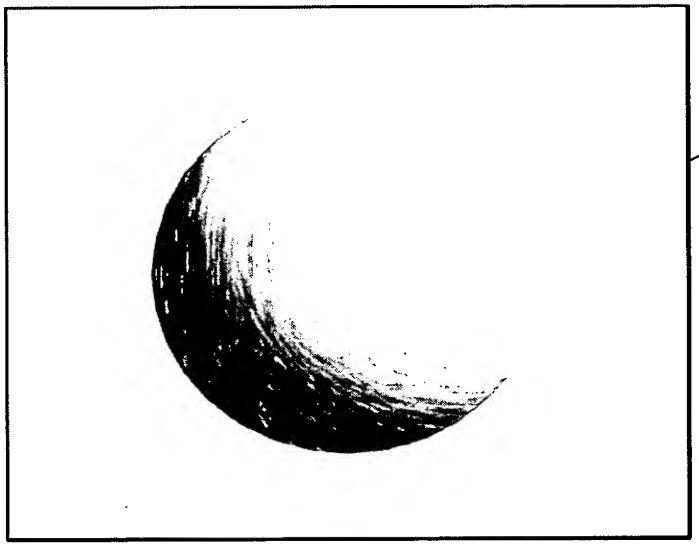


FIG 10

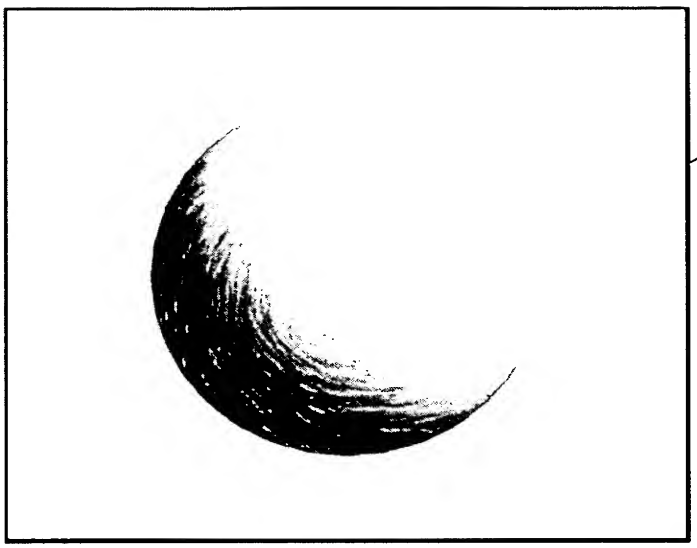


FIG.11

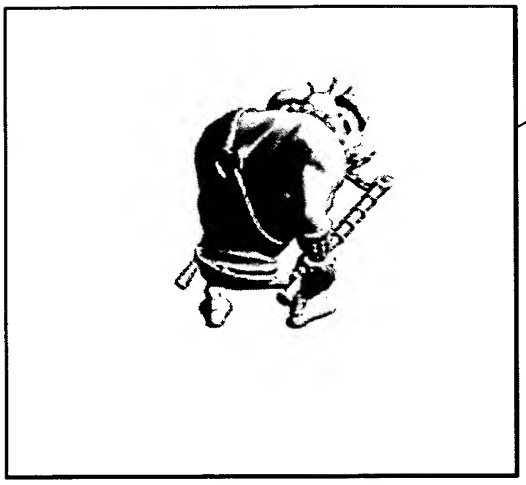


FIG.12

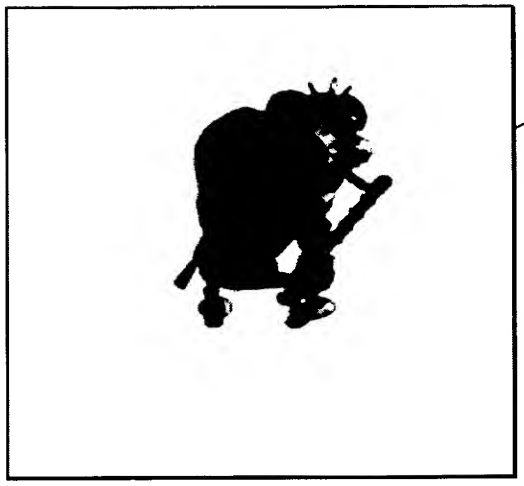


FIG.13

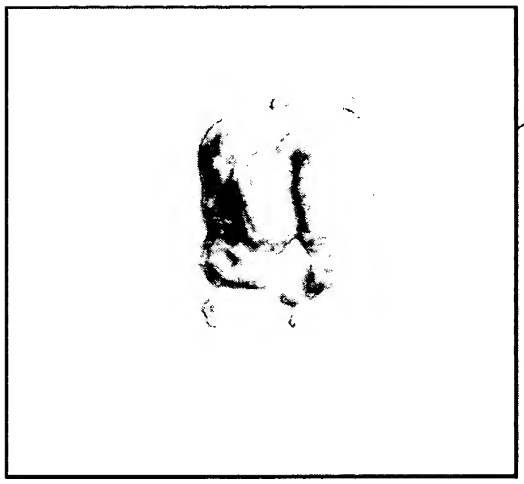


FIG.14A

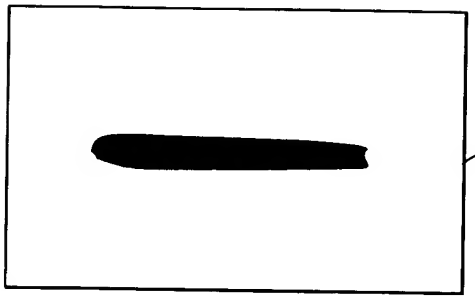


FIG.14B

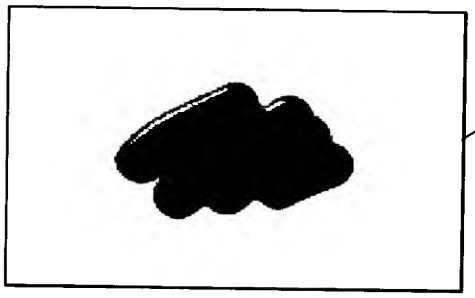


FIG.14C

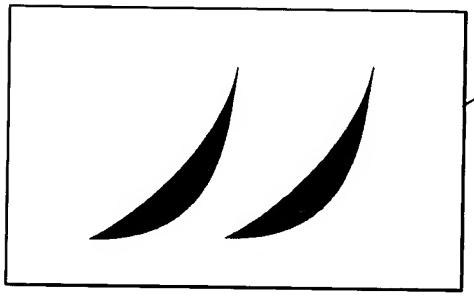


FIG.14D

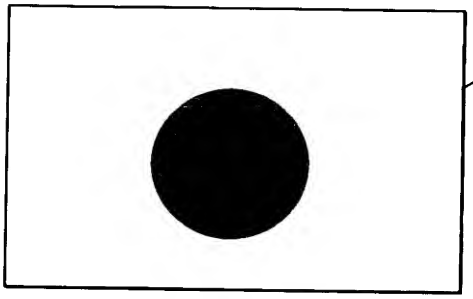


FIG 15

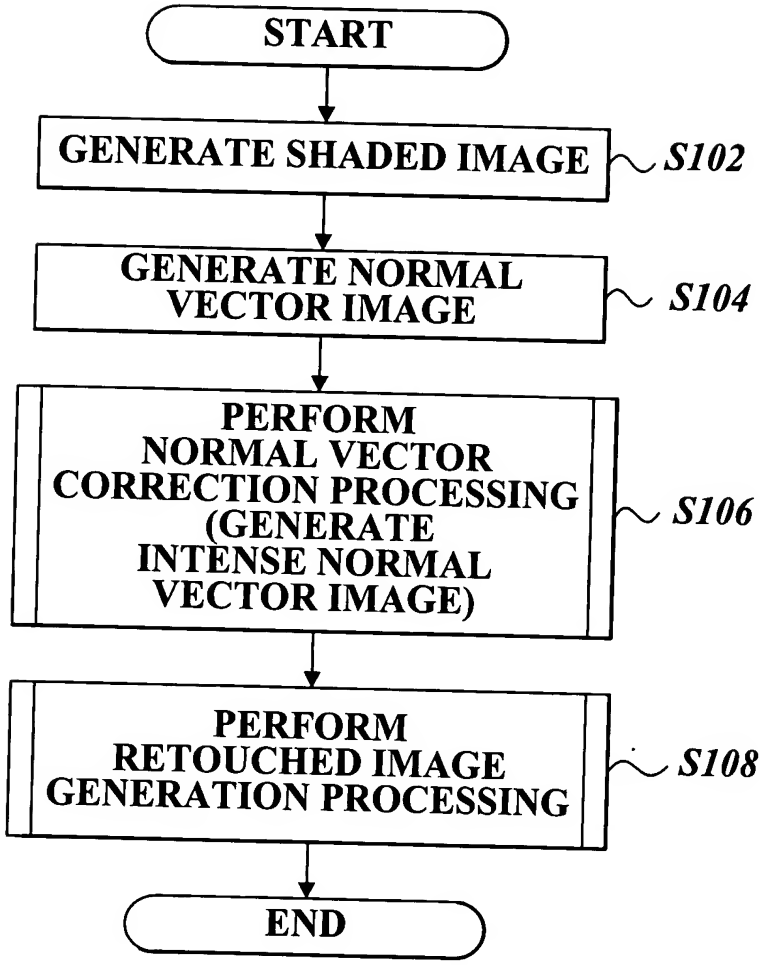

START
GENERATE SHADED IMAGE
S102
GENERATE NORMAL VECTOR IMAGE
S104
PERFORM NORMAL VECTOR CORRECTION PROCESSING (GENERATE INTENSE NORMAL VECTOR IMAGE)
S106
PERFORM RETOUCHED IMAGE GENERATION PROCESSING
S108
END

FIG 16

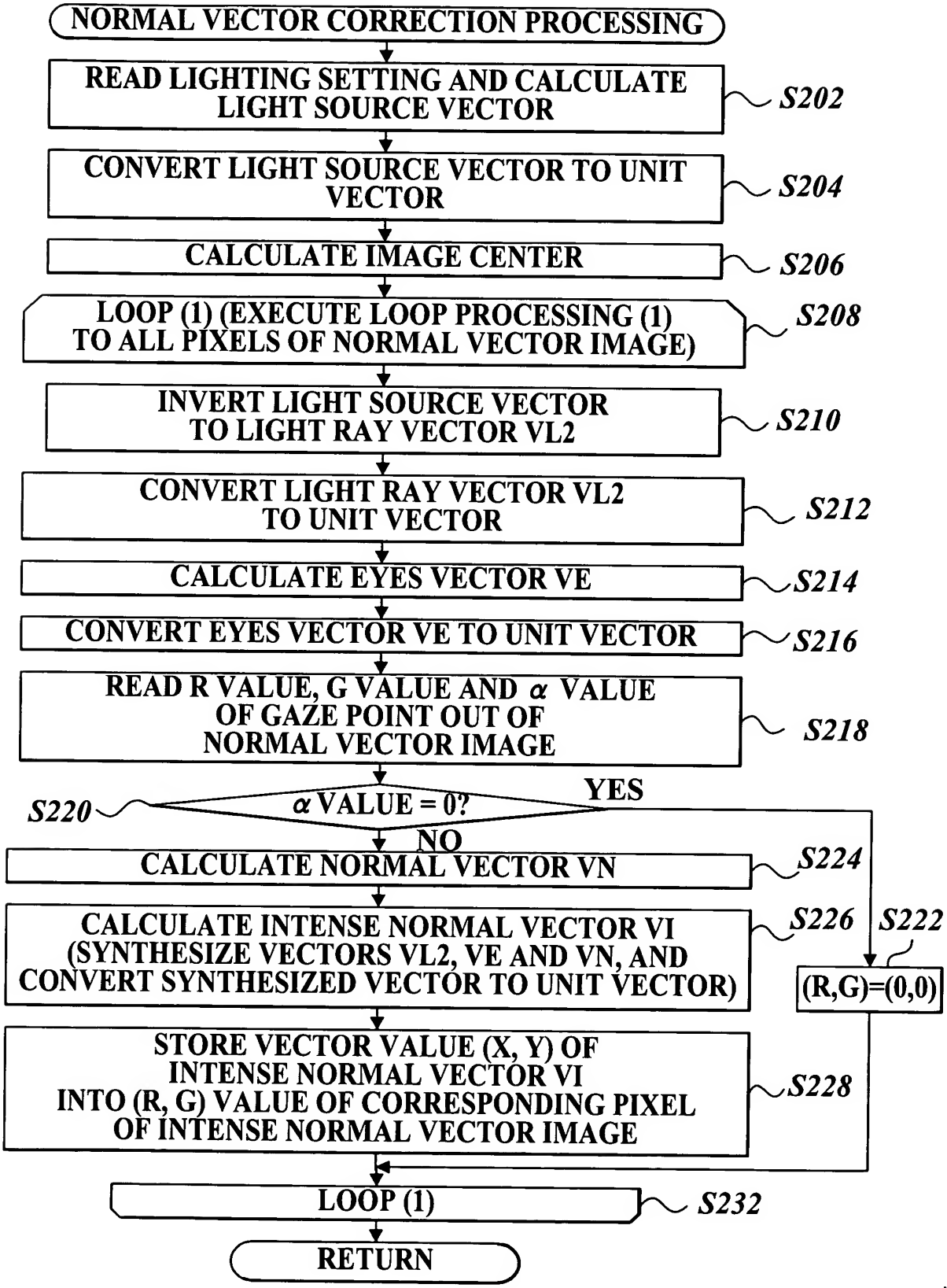

NORMAL VECTOR CORRECTION PROCESSING
READ LIGHTING SETTING AND CALCULATE LIGHT SOURCE VECTOR
S202
CONVERT LIGHT SOURCE VECTOR TO UNIT VECTOR
S204
CALCULATE IMAGE CENTER
S206
LOOP (1) (EXECUTE LOOP PROCESSING (1) TO ALL PIXELS OF NORMAL VECTOR IMAGE)
S208
INVERT LIGHT SOURCE VECTOR TO LIGHT RAY VECTOR VL2
S210
CONVERT LIGHT RAY VECTOR VL2 TO UNIT VECTOR
S212
CALCULATE EYES VECTOR VE
S214
CONVERT EYES VECTOR VE TO UNIT VECTOR
S216
READ R VALUE, G VALUE AND α VALUE OF GAZE POINT OUT OF NORMAL VECTOR IMAGE
S218
S220
α VALUE = 0?
YES
NO
CALCULATE NORMAL VECTOR VN
S224
CALCULATE INTENSE NORMAL VECTOR VI (SYNTHESIZE VECTORS VL2, VE AND VN, AND CONVERT SYNTHESIZED VECTOR TO UNIT VECTOR)
S226
S222
(R,G)=(0,0)
STORE VECTOR VALUE (X, Y) OF INTENSE NORMAL VECTOR VI INTO (R, G) VALUE OF CORRESPONDING PIXEL OF INTENSE NORMAL VECTOR IMAGE
S228
LOOP (1)
S232
RETURN

FIG 17

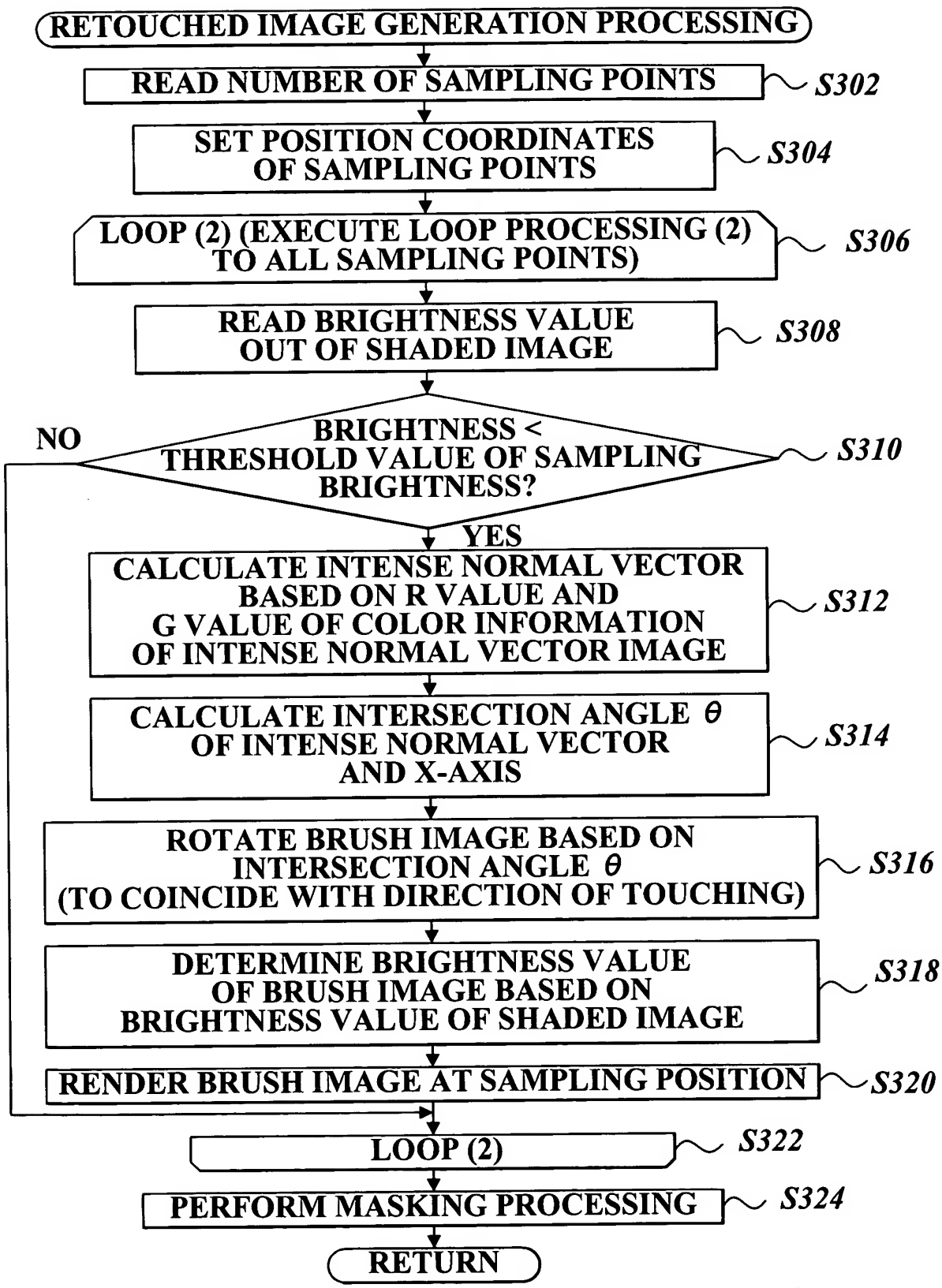

RETOUCHED IMAGE GENERATION PROCESSING
READ NUMBER OF SAMPLING POINTS
S302
SET POSITION COORDINATES OF SAMPLING POINTS
S304
LOOP (2) (EXECUTE LOOP PROCESSING (2) TO ALL SAMPLING POINTS)
S306
READ BRIGHTNESS VALUE OUT OF SHADED IMAGE
S308
NO
BRIGHTNESS < THRESHOLD VALUE OF SAMPLING BRIGHTNESS?
S310
YES
CALCULATE INTENSE NORMAL VECTOR BASED ON R VALUE AND G VALUE OF COLOR INFORMATION OF INTENSE NORMAL VECTOR IMAGE
S312
CALCULATE INTERSECTION ANGLE θ OF INTENSE NORMAL VECTOR AND X-AXIS
S314
ROTATE BRUSH IMAGE BASED ON INTERSECTION ANGLE θ (TO COINCIDE WITH DIRECTION OF TOUCHING)
S316
DETERMINE BRIGHTNESS VALUE OF BRUSH IMAGE BASED ON BRIGHTNESS VALUE OF SHADED IMAGE
S318
RENDER BRUSH IMAGE AT SAMPLING POSITION
S320
LOOP (2)
S322
PERFORM MASKING PROCESSING
S324
RETURN

FIG.18

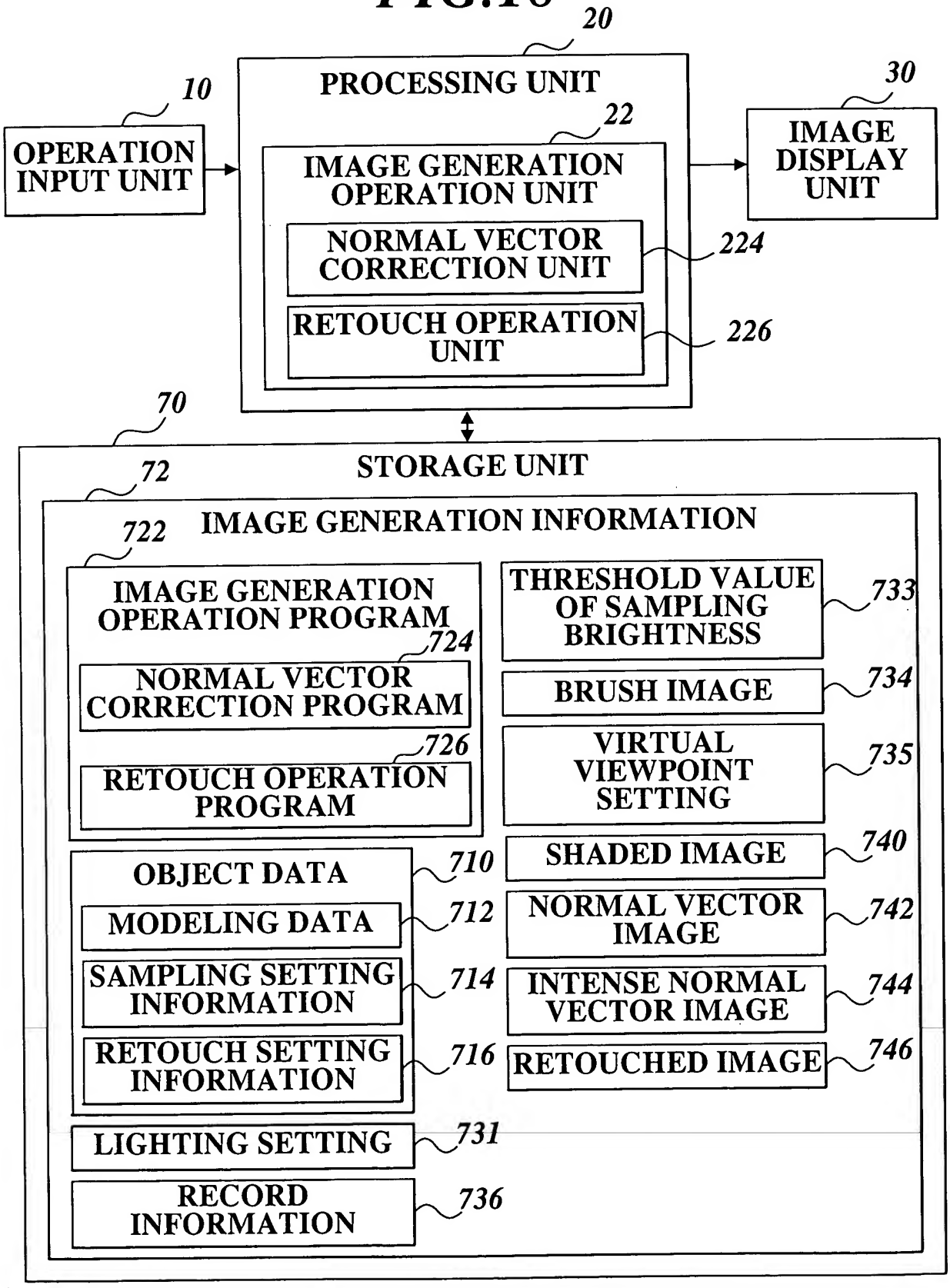

20
PROCESSING UNIT
10
OPERATION INPUT UNIT
22
IMAGE GENERATION OPERATION UNIT
NORMAL VECTOR CORRECTION UNIT
224
RETOUCH OPERATION UNIT
226
30
IMAGE DISPLAY UNIT
70
STORAGE UNIT
72
IMAGE GENERATION INFORMATION
722
IMAGE GENERATION OPERATION PROGRAM
724
NORMAL VECTOR CORRECTION PROGRAM
726
RETOUCH OPERATION PROGRAM
OBJECT DATA
710
MODELING DATA
712
SAMPLING SETTING INFORMATION
714
RETOUCH SETTING INFORMATION
716
LIGHTING SETTING
731
RECORD INFORMATION
736
THRESHOLD VALUE OF SAMPLING BRIGHTNESS
733
BRUSH IMAGE
734
VIRTUAL VIEWPOINT SETTING
735
SHADED IMAGE
740
NORMAL VECTOR IMAGE
742
INTENSE NORMAL VECTOR IMAGE
744
RETOUCHED IMAGE
746

FIG.19

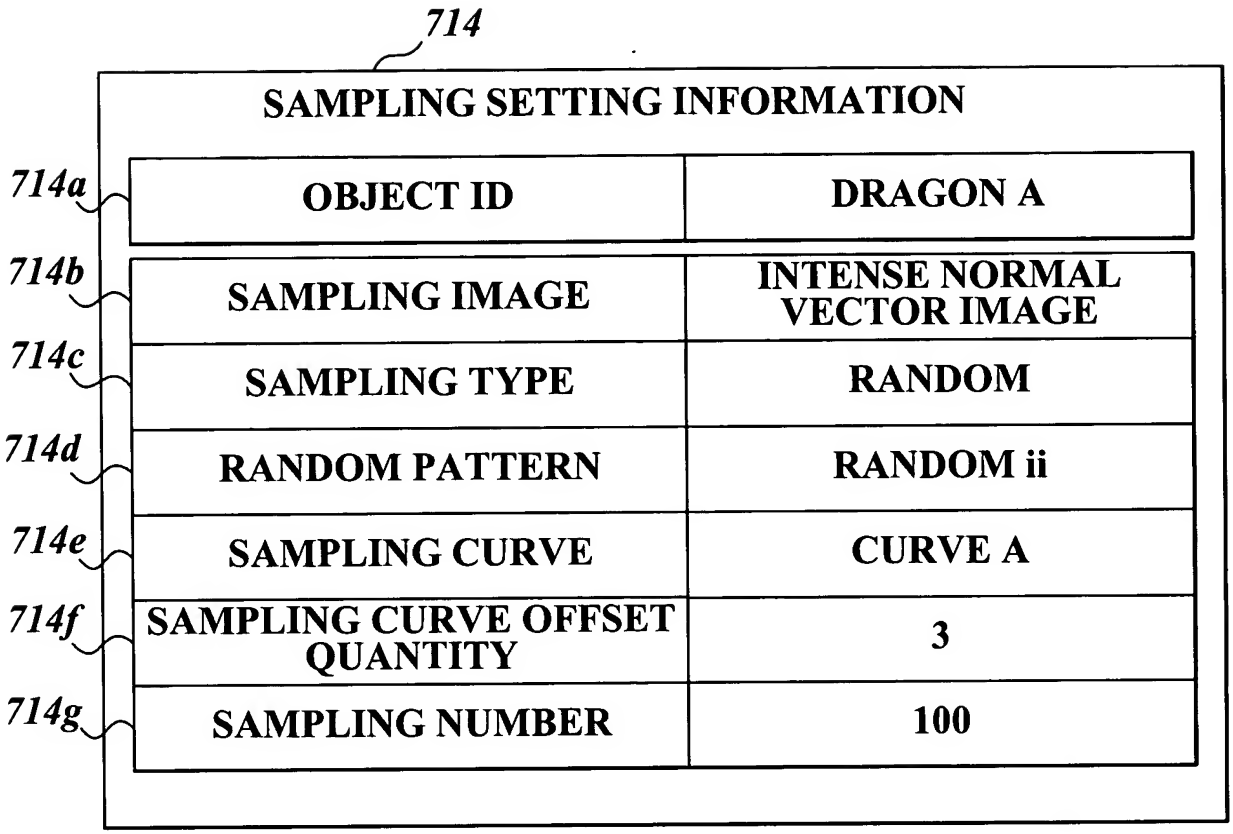

714
SAMPLING SETTING INFORMATION
714a
OBJECT ID
DRAGON A
714b
SAMPLING IMAGE
INTENSE NORMAL VECTOR IMAGE
714c
SAMPLING TYPE
RANDOM
714d
RANDOM PATTERN
RANDOM ii
714e
SAMPLING CURVE
CURVE A
714f
SAMPLING CURVE OFFSET QUANTITY
3
714g
SAMPLING NUMBER
100

FIG.20

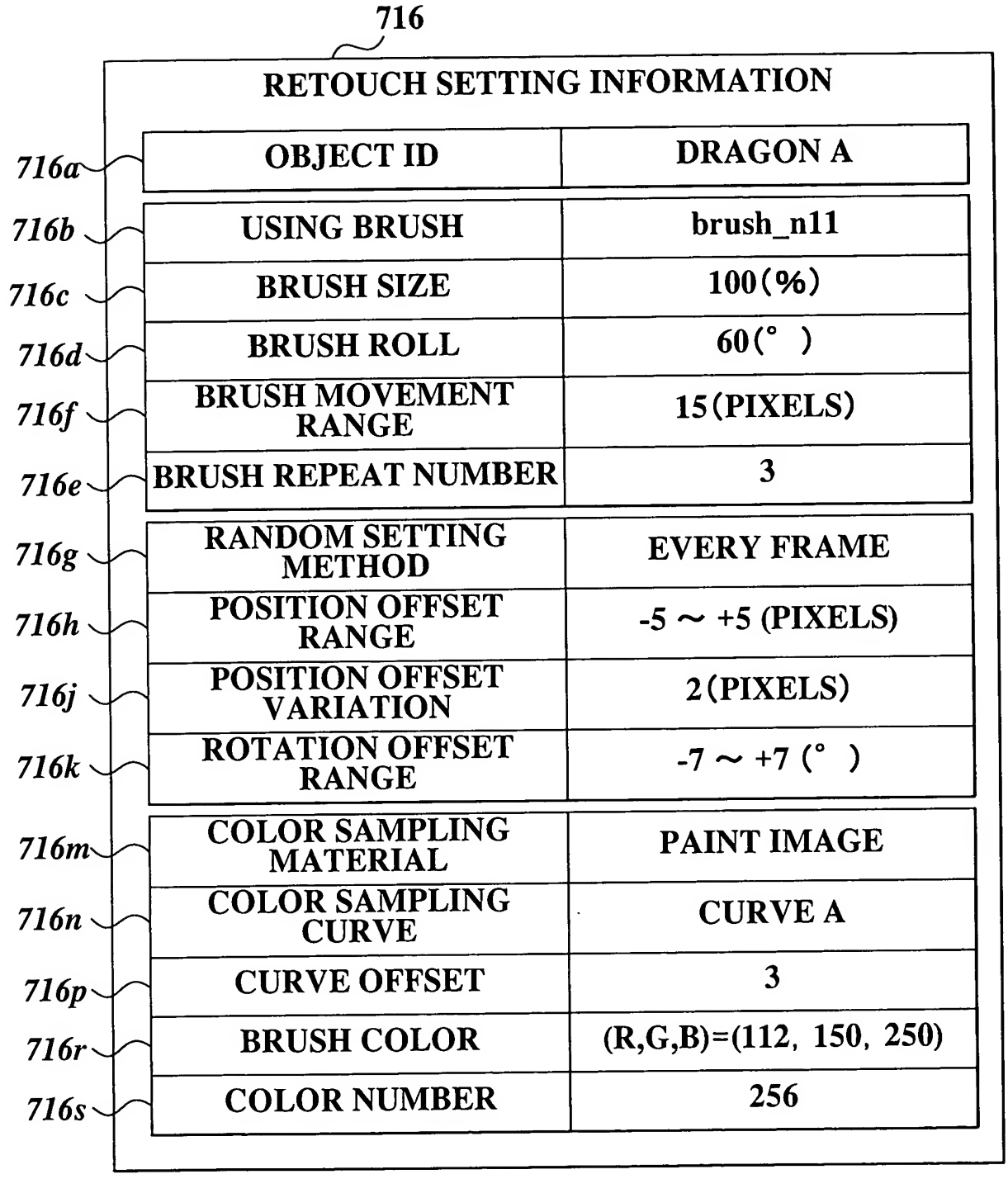

716
RETOUCH SETTING INFORMATION
716a
OBJECT ID
DRAGON A
716b
USING BRUSH
brush_n11
716c
BRUSH SIZE
100(%)
716d
BRUSH ROLL
60(°)
716f
BRUSH MOVEMENT RANGE
15(PIXELS)
716e
BRUSH REPEAT NUMBER
3
716g
RANDOM SETTING METHOD
EVERY FRAME
716h
POSITION OFFSET RANGE
-5 ～ +5 (PIXELS)
716j
POSITION OFFSET VARIATION
2(PIXELS)
716k
ROTATION OFFSET RANGE
-7 ～ +7 (°)
716m
COLOR SAMPLING MATERIAL
PAINT IMAGE
716n
COLOR SAMPLING CURVE
CURVE A
716p
CURVE OFFSET
3
716r
BRUSH COLOR
(R,G,B)=(112, 150, 250)
716s
COLOR NUMBER
256

FIG 21A

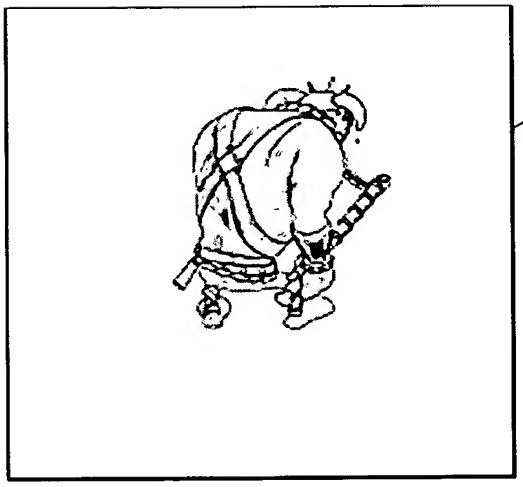


FIG.21B

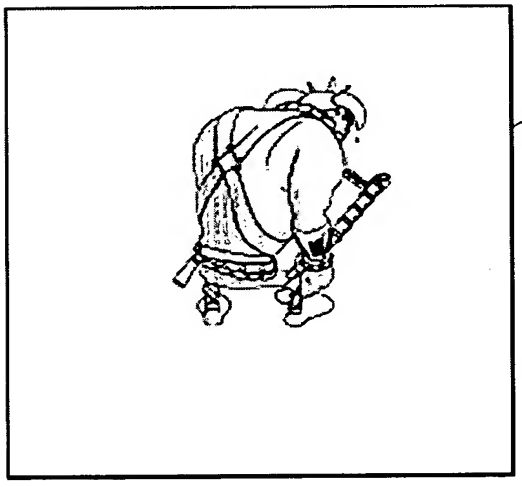


FIG.22A

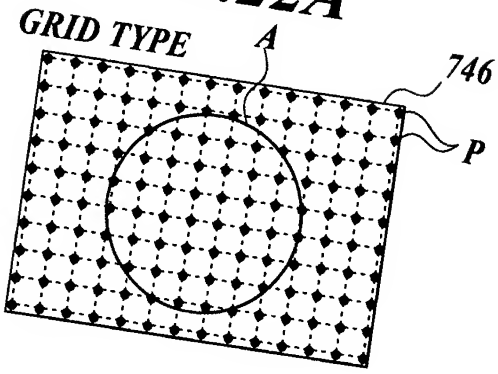


FIG.22B

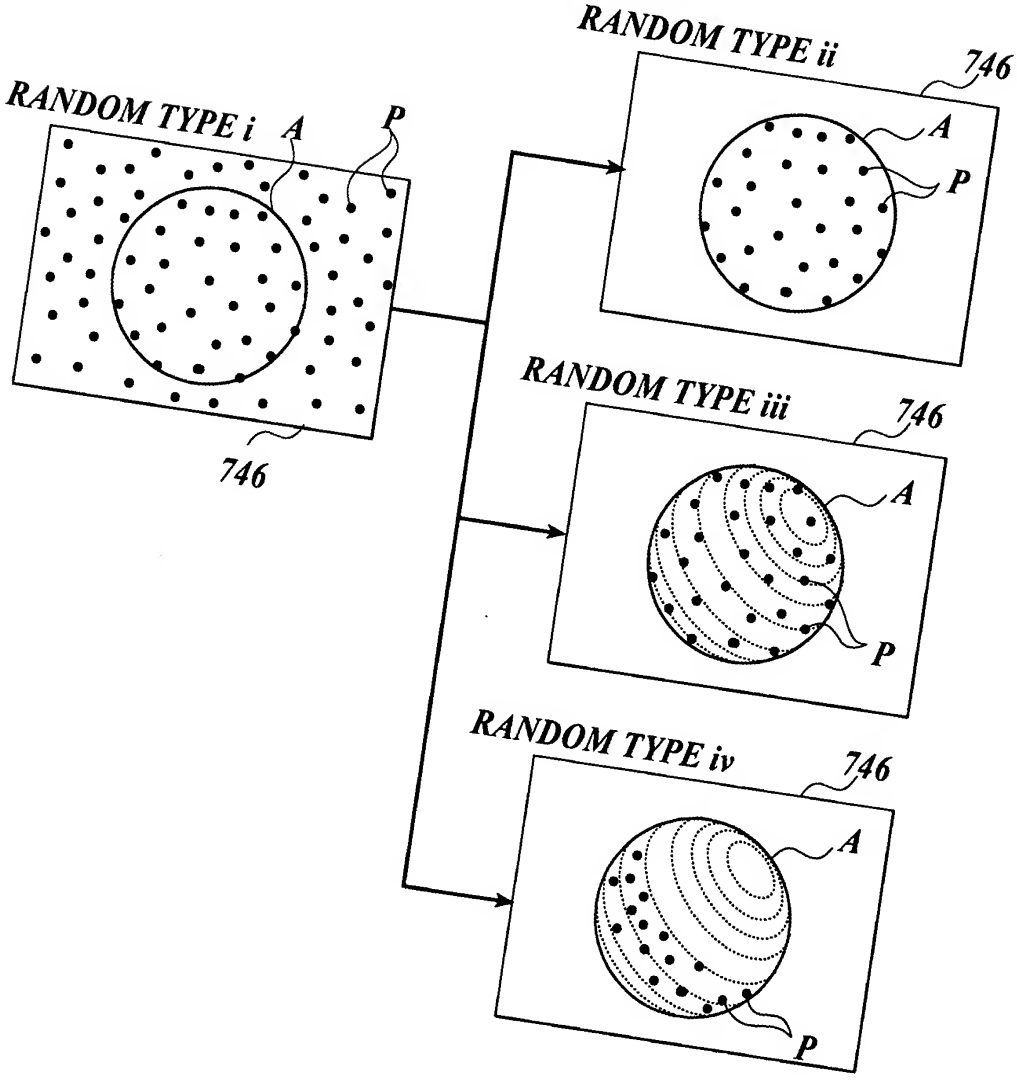


FIG 23A

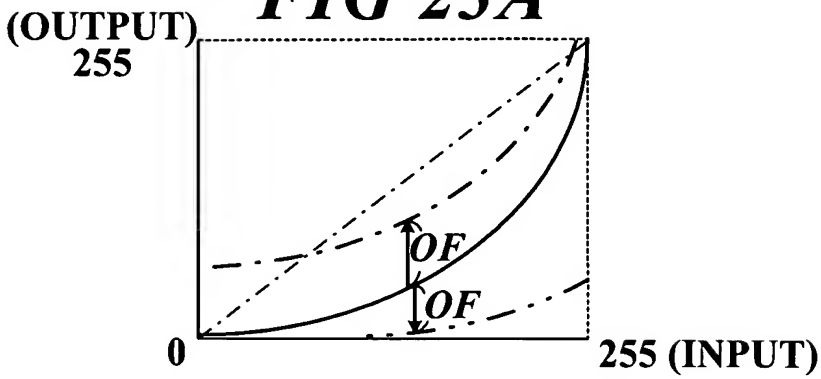


FIG.23B

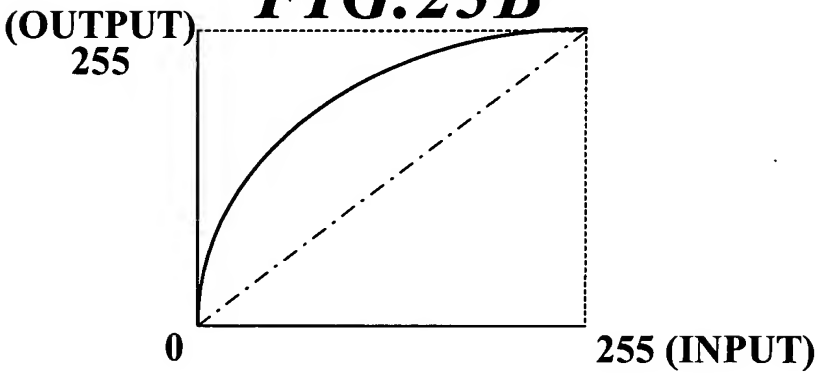


FIG.23C

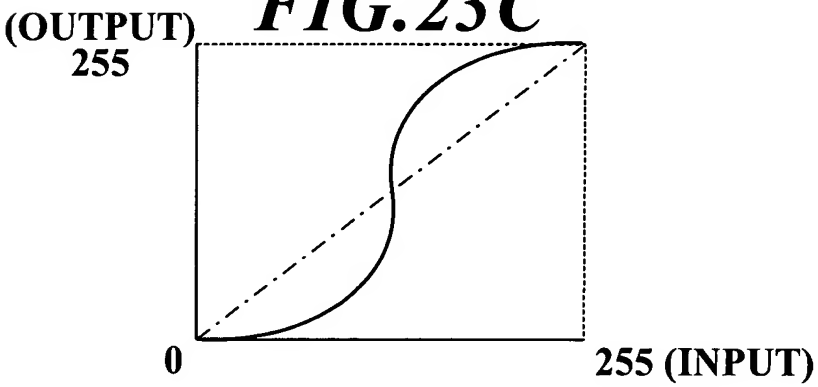


FIG.23D

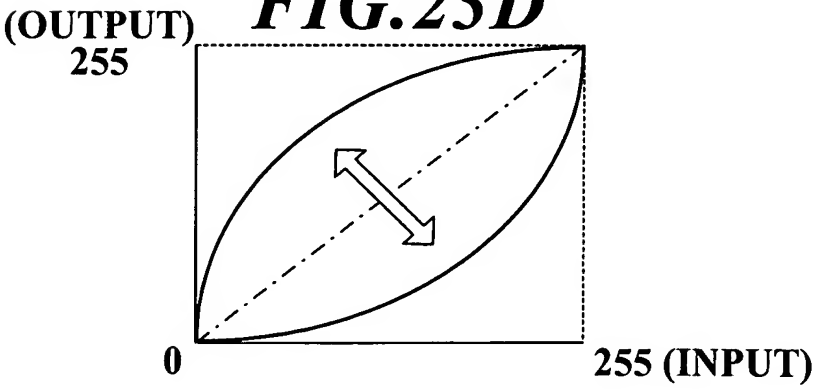


FIG.24A

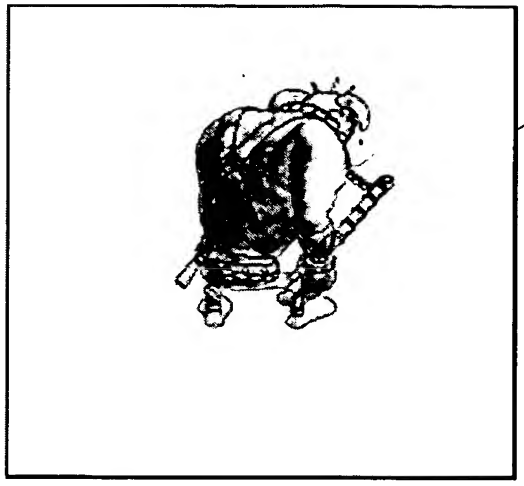


FIG.24B

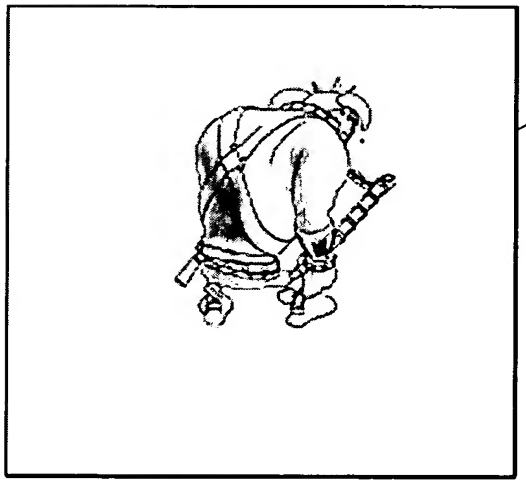


FIG.25A

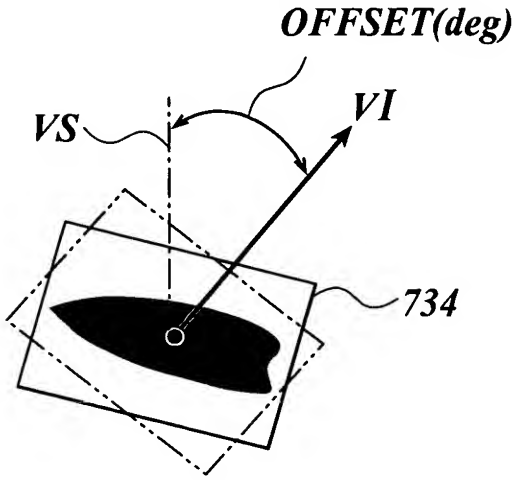


FIG.25B

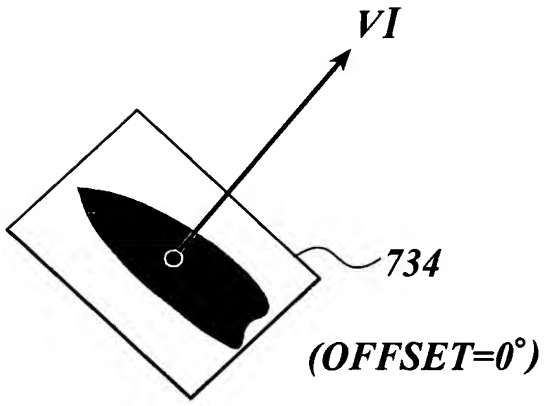


FIG.25C

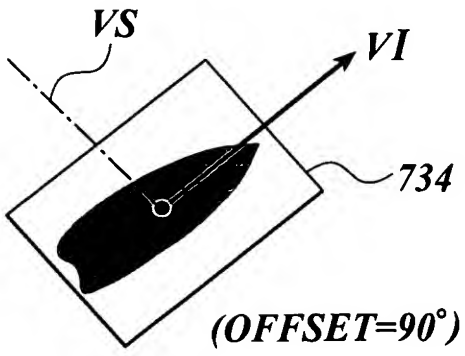


FIG.26

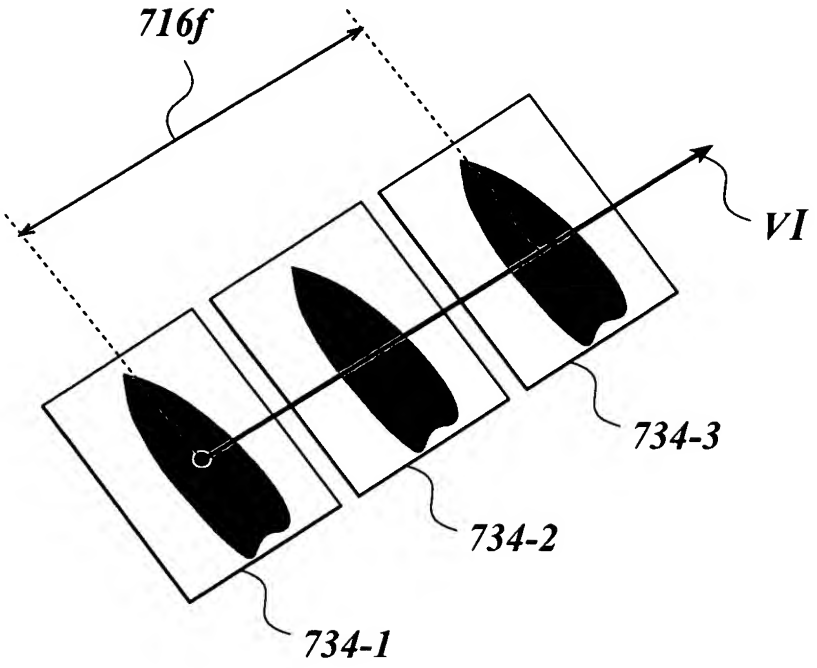


FIG.27

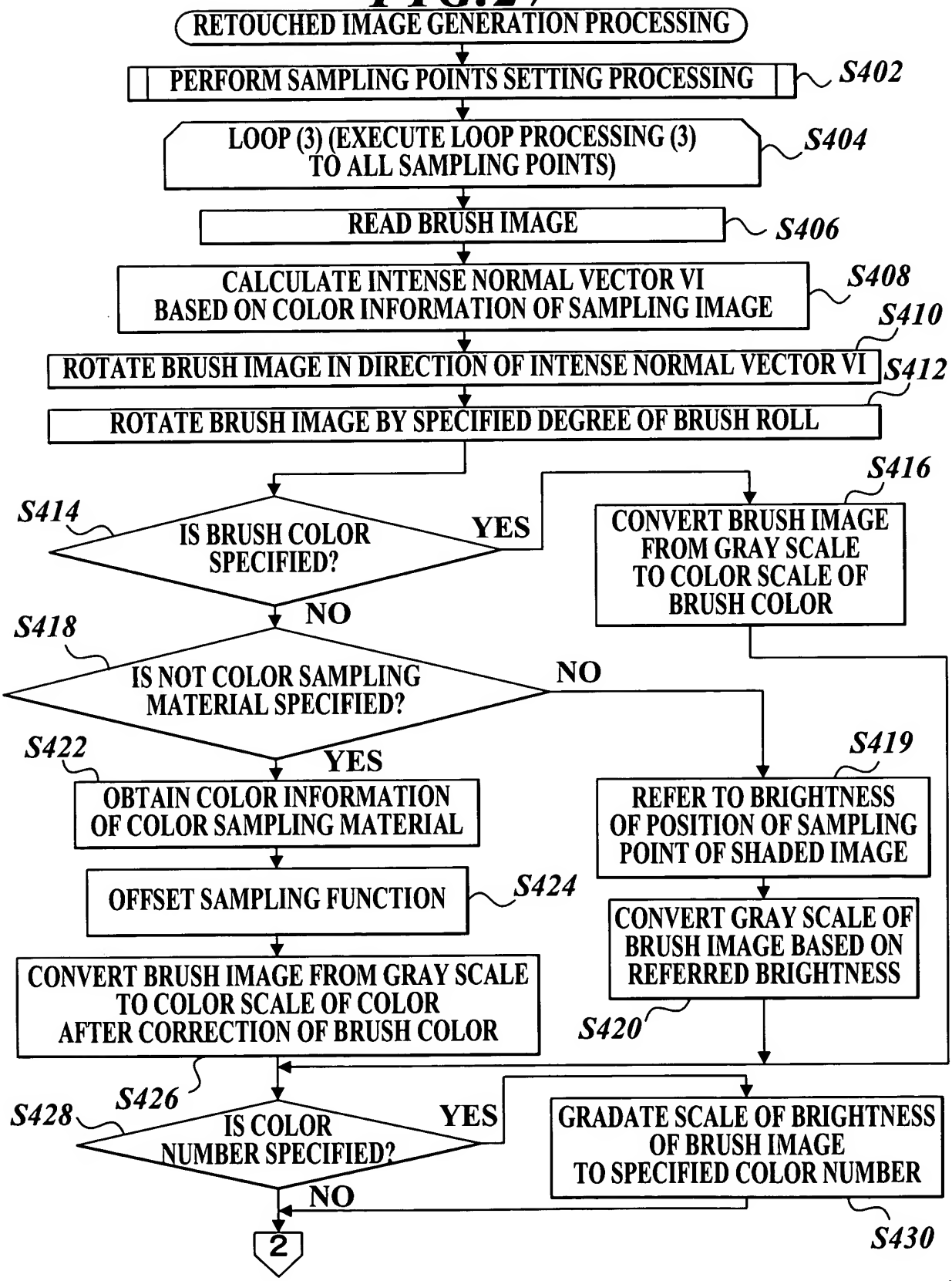

RETOUCHED IMAGE GENERATION PROCESSING
PERFORM SAMPLING POINTS SETTING PROCESSING
S402
LOOP (3) (EXECUTE LOOP PROCESSING (3) TO ALL SAMPLING POINTS)
S404
READ BRUSH IMAGE
S406
CALCULATE INTENSE NORMAL VECTOR VI BASED ON COLOR INFORMATION OF SAMPLING IMAGE
S408
S410
ROTATE BRUSH IMAGE IN DIRECTION OF INTENSE NORMAL VECTOR VI
S412
ROTATE BRUSH IMAGE BY SPECIFIED DEGREE OF BRUSH ROLL
S414
IS BRUSH COLOR SPECIFIED?
YES
NO
S416
CONVERT BRUSH IMAGE FROM GRAY SCALE TO COLOR SCALE OF BRUSH COLOR
S418
IS NOT COLOR SAMPLING MATERIAL SPECIFIED?
NO
YES
S419
S422
OBTAIN COLOR INFORMATION OF COLOR SAMPLING MATERIAL
REFER TO BRIGHTNESS OF POSITION OF SAMPLING POINT OF SHADED IMAGE
OFFSET SAMPLING FUNCTION
S424
CONVERT GRAY SCALE OF BRUSH IMAGE BASED ON REFERRED BRIGHTNESS
CONVERT BRUSH IMAGE FROM GRAY SCALE TO COLOR SCALE OF COLOR AFTER CORRECTION OF BRUSH COLOR
S420
S426
S428
IS COLOR NUMBER SPECIFIED?
YES
NO
GRADATE SCALE OF BRIGHTNESS OF BRUSH IMAGE TO SPECIFIED COLOR NUMBER
S430
2

FIG.28

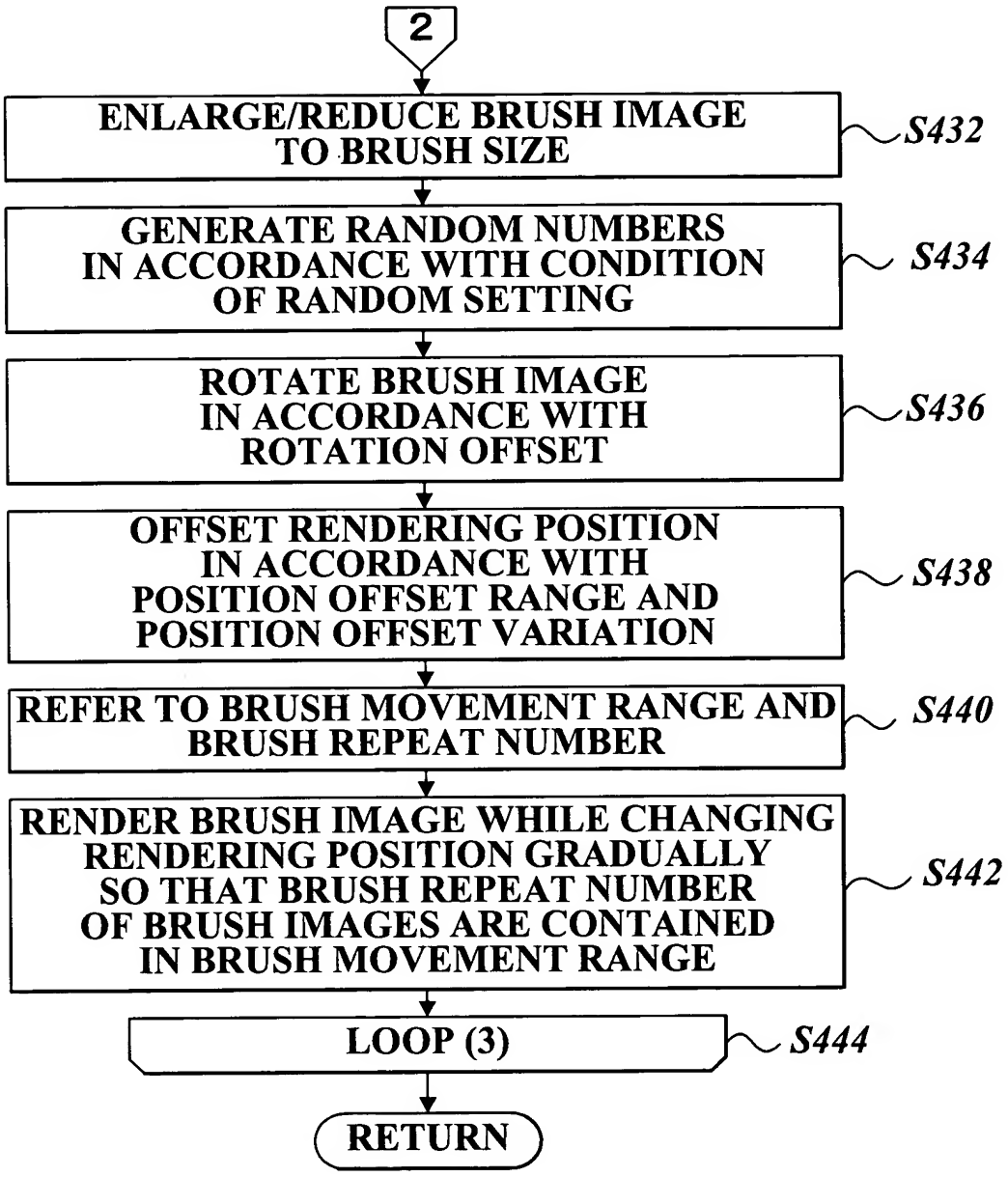

2
ENLARGE/REDUCE BRUSH IMAGE TO BRUSH SIZE
S432
GENERATE RANDOM NUMBERS IN ACCORDANCE WITH CONDITION OF RANDOM SETTING
S434
ROTATE BRUSH IMAGE IN ACCORDANCE WITH ROTATION OFFSET
S436
OFFSET RENDERING POSITION IN ACCORDANCE WITH POSITION OFFSET RANGE AND POSITION OFFSET VARIATION
S438
REFER TO BRUSH MOVEMENT RANGE AND BRUSH REPEAT NUMBER
S440
RENDER BRUSH IMAGE WHILE CHANGING RENDERING POSITION GRADUALLY SO THAT BRUSH REPEAT NUMBER OF BRUSH IMAGES ARE CONTAINED IN BRUSH MOVEMENT RANGE
S442
LOOP (3)
S444
RETURN

FIG 29

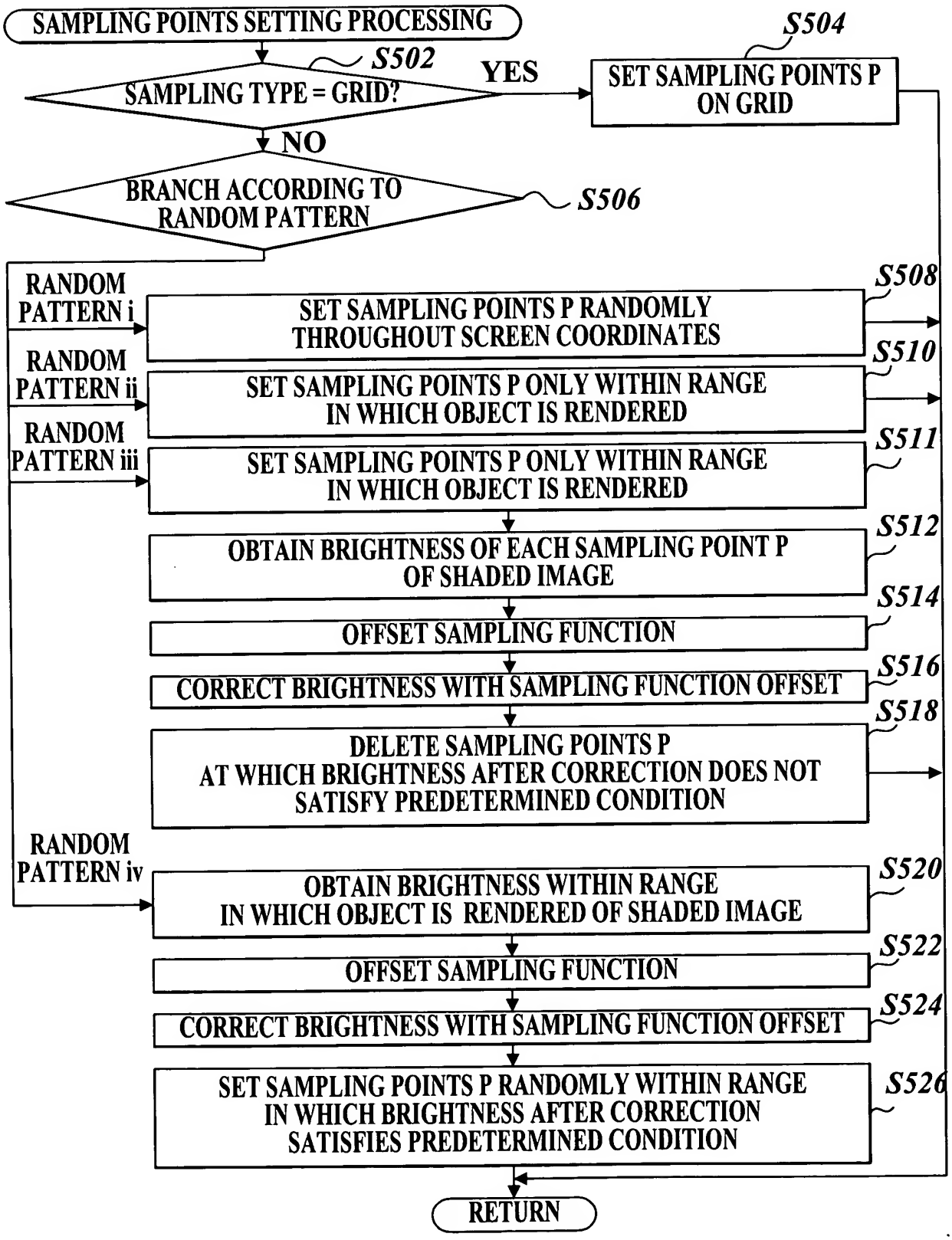
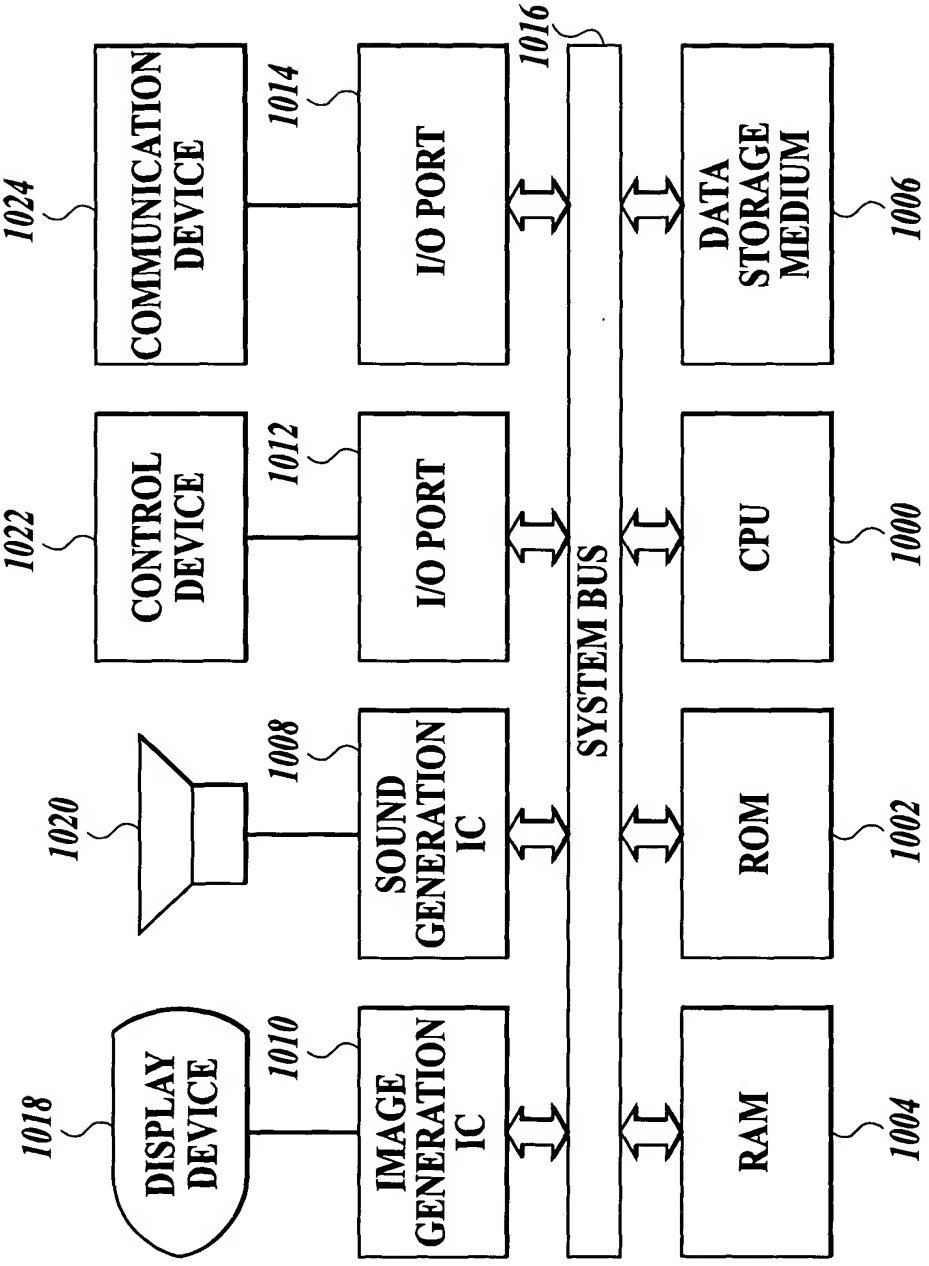

SAMPLING POINTS SETTING PROCESSING
S502
SAMPLING TYPE = GRID?
YES
S504
SET SAMPLING POINTS P ON GRID
NO
BRANCH ACCORDING TO RANDOM PATTERN
S506
RANDOM PATTERN i
S508
SET SAMPLING POINTS P RANDOMLY THROUGHOUT SCREEN COORDINATES
RANDOM PATTERN ii
S510
SET SAMPLING POINTS P ONLY WITHIN RANGE IN WHICH OBJECT IS RENDERED
RANDOM PATTERN iii
S511
SET SAMPLING POINTS P ONLY WITHIN RANGE IN WHICH OBJECT IS RENDERED
S512
OBTAIN BRIGHTNESS OF EACH SAMPLING POINT P OF SHADED IMAGE
S514
OFFSET SAMPLING FUNCTION
S516
CORRECT BRIGHTNESS WITH SAMPLING FUNCTION OFFSET
S518
DELETE SAMPLING POINTS P AT WHICH BRIGHTNESS AFTER CORRECTION DOES NOT SATISFY PREDETERMINED CONDITION
RANDOM PATTERN iv
S520
OBTAIN BRIGHTNESS WITHIN RANGE IN WHICH OBJECT IS RENDERED OF SHADED IMAGE
S522
OFFSET SAMPLING FUNCTION
S524
CORRECT BRIGHTNESS WITH SAMPLING FUNCTION OFFSET
S526
SET SAMPLING POINTS P RANDOMLY WITHIN RANGE IN WHICH BRIGHTNESS AFTER CORRECTION SATISFIES PREDETERMINED CONDITION
RETURN

FIG.30


1018
DISPLAY DEVICE
1010
IMAGE GENERATION IC
1020
1008
SOUND GENERATION IC
1022
CONTROL DEVICE
1012
I/O PORT
1024
COMMUNICATION DEVICE
1014
I/O PORT
1016
SYSTEM BUS
RAM
1004
ROM
1002
CPU
1000
DATA STORAGE MEDIUM
1006